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MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

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W. H. M. CHRISTIE, M.A., F.R.S., President, in the Chair.

Alfred Fowler, Demonstrator of Astronomical Physics, Normal School of Science, South Kensington, S.W.;

Joseph Kleiber, Privat-Docent of the University of St. Petersburg;

David Smart, L.R.C.P., M.R.C.S., L.S A., 108 Grange Road, Bermondsey, S.E.,

were balloted for and duly elected Fellows of the Society.

The following Candidates were proposed as Fellows of the Society, the name of the proposer from personal knowledge being appended:—

James Blair Forgan, 15 Pall Mall, S.W. (proposed by C. Piazzi Smyth);

Richard A. Gregory, Assistant Solar Physics Committee, South Kensington, 115 Rylston Road, Fulham, S.W. (proposed by J. Norman Lockyer);

A. N. Harris, hotel keeper, 21 Lambhay Street, Plymouth (proposed by the Rev. J. M. Bacon);

Frederick William Henkel, jun., merchant, 32 Berwick Road, Walthamstow (proposed by J. D. McClure).

On some of the Features of the Arrangement of Stars in Space.

By Edward S. Holden, LL.D., Foreign Associate.

Under ordinary circumstances, observers with equatorial telescopes use eyepieces which have fields hardly larger than 10 or 15 minutes of arc. As a consequence of this, features of the sky which have great extension are utterly lost to them. Long streams of stars (and these are often one, two, or more degrees in length), large nebulæ (such as those of *Orion* and *Andromeda*), and objects of a similar nature are not well seen, and their true relations to the surrounding stars are not discovered. If the telescope is used in sweeps, as was done by Sir William Herschel,

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some of the disadvantages of small fields are done away with by the method of observation itself. I had striking proof of this in my experience with the 15½-inch equatorial of the Washburn Observatory, which was used in this manner. If the observations with small fields, or those made in sweeps, are charted, then some of the larger features of the sky will be reproduced on paper, and can be discovered and studied at leisure.

This method was employed with fruitful results by the late Mr. Proctor.

It may almost be said that only those astronomers who are in the habit of using large fields (and therefore low powers) obtain a vivid idea of the aspect of the larger features of the heavens. Such a vivid conception can always be attained under these circumstances; but when attained it is almost impossible to convey an accurate notion of it to others without constructing a careful chart of what is seen. This, of course, is usually impossible. I may illustrate my meaning by supposing an observer to be viewing the Milky Way with an eyepiece having a field of 8′ or 10′. The whole field will be filled with stars apparently scattered at random. Neither the stars nor the unoccupied spaces of the background will suggest any order.

Occasionally a double star will pass through the field of view, and the mind at once seizes on this; for here is a definiteness and order which gives a sense of relief from the chaos of stars among which it chances to fall. Small nebulæ have the same effect. We have certain definite notions about them also. If the eyepiece is changed to one which gives twice or thrice the field of view, and if the observer has acquired the skill to see with this power nearly all that is shown with the higher power, then the sense of order which the mind instinctively seeks for can often be found in the arrangement of the stars themselves. Half a dozen stars in a row pass by with only a moment's attention in the smaller field, but when we see the first six stars succeeded by a stream of six, ten, or twenty more, the attention becomes rivetted on this feature, and there is a positive sense of pleasure in tracing such a stream to its end. Some fields and regions are characterised by streams like this. Others are rich in small definite ellipses of stars, often all of the same size. In some cases stars are surrounded by circles of other fainter stars. In other instances the ellipses become tolerably regular ovals, often of large size. These interlace in the most intricate manner. After having discovered such ovals as these we can frequently trace new and highly interesting features of the kind by paying attention to stars of one magnitude only. If we regard the 11th magnitude stars alone, for example, we may find rings and ovals of these stars forming a regular pattern in the sky. Interlacing with these may be found another pattern of similar ovals (usually smaller) of stars of the 12th magnitude, and so on.

In certain parts of the sky the arrangement is so intricate

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that no single pattern can be discovered. In most regions a little attention will show that there are several patterns, one for each of the fainter magnitudes of stars. I have spoken of these patterns and arrangements at some length in the *Century Magazine* for September 1888, and have suggested some consequences which may follow from a study of them. The idea of them was derived from actual observations of the heavens with the equatorial of the Washburn Observatory in 1884 and 1885. It is extremely difficult to convey notions of this sort to a reader, or to anyone who has not the field of stars actually before him in the telescope. At one time I endeavoured to surmount this difficulty by tracing from some of Peters' Ecliptic Charts successively the stars of the 10th magnitude, then those of the 11th, then those of the 12th, and so on. Thus each one of Peters' charts gave me four or five different maps, each containing stars of one magnitude only. Each one of these maps was studied separately, to find out the arrangement or pattern of the stars of that particular magnitude at that particular place; and a comparison of the patterns from two maps threw some light on the question as to whether the stars of the two magnitudes in question were or were not connected in space. Immense pains were necessary in tracing the separate maps, and even after they were made they were not easy to compare.

We have now in photography a means of making these researches in a more satisfactory manner. A series of charts of a given region can be made by giving successive exposures of 30, 60, 90, 150, 180, &c., minutes, with the same lens. It is possible to get excellent definition with a portrait lens over an area of 25 square degrees; and at least tolerable definition can be obtained over 100 square degrees. If the lens is of 6 or 8 inches aperture, stars of the 12th, 13th, or even 14th magnitude can be registered without going to excessively long exposures. In this way, then, we have immense advantages in exhibiting the larger features of the sky. It is only necessary to photograph them, to copy the original negative, and on this copy to mark such lines as will direct attention to the features in question. It will not do so well to simply reproduce the negative. There is an art in examining an astronomical photograph which is akin to the art of observing with an astronomical telescope, although it is easy to acquire, so that it is desirable to indicate the main features in the way I have suggested, and then to leave the eye to trace out the remainder of the figure or pattern. If too many lines are traced on the negative the eye becomes confused. The lines drawn on *negatives* should represent the areas of fewer stars. Lines drawn on *positives* should represent areas of many stars.

Mr. Barnard, of the Lick Observatory, has lately made some very interesting experiments with a portrait lens of nearly 6 inches aperture and 31 inches focus. Some of his photographs of the Milky Way are of extreme beauty. I have examined

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these in the manner described, and some of them are reproduced in the accompanying photographs. It must be understood, of course, that these photographs are intended mainly as *diagrams*, to bring out the various patterns which are to be found in the arrangements of the star-groups. The successive copyings of the negative, and especially the interpolation of the guiding lines, have naturally injured the pictorial effect.

Lick Observatory:
1889 *September* 1.

The following photographs illustrating this paper are placed in the Library:—

1, 2. Milky Way, R.A. $18^h\ 44^m$, Decl. − 6° (Messier 11)
3, 4. Milky Way, R.A. $17^h\ 56^m$, Decl. − 28°.
5. Milky Way, R.A. $18^h\ 11^m$, Decl. − 20°.
6, 7. Nebula of Andromeda.

Note on the Spectrum of the Sun-spot of June 1889.
By the Rev. A. L. Cortie, S.J.

(*Communicated by E. W. Maunder.*)

In *Nature* of December 5, 1889, a list of bright lines is given which were observed by Professor Spörer, of Potsdam, on June 28, in a prominence that appeared as the large spot of that month was disappearing over the Sun's edge. The spectrum of this spot in the region D to B was observed at Stonyhurst on June 20, 22, 24, 26, and 27, the instrument used being the Browning automatic spectroscope, with a dispersion of twelve prisms of 60°. Of the seven lines measured by Professor Spörer in the same part of the spectrum of the prominence, excluding D_1, D_2, and C, four are due to calcium, the wave-lengths given being 672·6, 671·6, 649·2, and 646·2. Three other lines of calcium were observed between D and *b*, so that this element was very conspicuous in the prominence. In the spectrum of the spot all the lines given in Ångström's maps as due to calcium were seen to be widened; and of these the lines at 6492·41 and 6461·98, corresponding to Spörer's 649·2 and 646·2, were amongst the most widened lines in the spot, understanding by the term "most widened lines" those lines which were widened more than once their normal breadth. Four other calcium lines were also in this category, their wave-lengths being 6498·25, 6468·78, 6449·29, and 6438·35 respectively, and the widening of the rest was considerable, in no case being less than one-half the normal breadth of the line. Calcium was therefore also very conspicuous in the spectrum of the spot. On June 27 the line at 6492·41—one of the lines seen by Spörer the next day in the prominence—was widened no less than three times its normal breadth. On this day, when the spot was very near the edge of the Sun, several lines were seen to be displaced towards the violet end of the spectrum, among them being the iron lines, 6300·5, 6298·74, 6251·76, 6253·40, and particularly the calcium lines 6101·92 and 6121·34, although no displacement was noted in the calcium